DOCUMENT RESUME

ED 179 918 CS 005 142

AUTHOR Moe, Alden J.: And Others
TITLE The Literacy Requirements of a Heating and Air Conditioning Mechanic on the Job and In a Vocational Training Program.
INSTITUTION Purdue Univ., Lafayette, Ind. Dept. of Education.
SPONS AGENCY Indiana State Dept. of Public Instruction, Indianapolis.: Office of Education (DHEW), Washington, D.C.
PUB DATE Nov 79
NOTE 61p.: For related document, see CS 005 141

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Adult Basic Education: *Adult Education Programs: *Adult Vocational Education: Air Conditioning Equipment: Basic Skills: Communication Skills; Heating: *Job Skills: *Literacy: *Machine Repairmen: Reading Skills: Vocabulary

ABSTRACT

As part of a project that identified the specific literacy skills required in ten occupations, this report provides two levels of instructional information about heating/air conditioning mechanics. Factual data are presented in Parts I and II for use in decision making by program developers, administrators, teachers, and counselors. These sections note the specific literacy requirements (reading, writing, listening, speaking, and mathematics) that were identified at three job sites and three vocational training programs. Part III presents instructional methods/materials that adult basic education teachers can use to develop literacy skills while imparting job related knowledge. The lesson format is based on a directed reading activity and includes vocabulary and concept development, sentence and organizational structure, silent reading, and skill development. Appendixes list the technical vocabulary that heating/air conditioning mechanics need to know, the 100 words that represent 45% of the language sampled for the entire project, and occupational literacy requirements for the ten occupations that were studied. (RL)

****
* Reproductions supplied by EDPS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

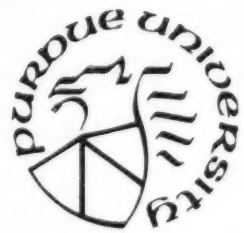
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

THE LITERACY REQUIREMENTS OF A HEATING AND AIR CONDITIONING MECHANIC ON THE JOB AND IN A VOCATIONAL TRAINING PROGRAM

ED179918

Alden J. Moe
R. Timothy Rush
Rebecca L. Storlie

Department of Education
Purdue University



November 1979

CS005142

This project was completed through grants from the Indiana Department of Public Instruction under Section 309 of the Adult Education Act, P.L. 91-230 and Sections 310 of the Adult Education Act, P.L. 91-230 as amended. The data collection and initial completion of the literacy reports (from which this report was derived) was completed during 1978-79 under Project Number FY-79-8062-P. This report, one of ten, was revised for dissemination during 1979-80 under Project Number FY-80-8075-T.

* * *

The activity which is the subject of this report was supported in part by the U. S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

Acknowledgements

In order to conduct this project, the cooperation of approximately 100 individuals in the Greater Lafayette, Indiana, area was required. A grateful acknowledgement is extended to those many individual workers, students, instructors, program directors, union officials, personnel directors, foremen, supervisors, and others who allowed us to work with them and to identify the literacy demands discussed in this report.

The guidance and support of Linda Zeiler and Timothy Wells of the Division of Adult and Community Education of the Indiana State Department of Public Instruction is also gratefully acknowledged.

The editorial expertise provided by Robert Hieb is much appreciated. Finally, many thanks to Shelly Richardson and Ricki Freiman for their secretarial assistance.

Alden J. Moe
Project Director
Purdue University
West Lafayette, IN

TABLE OF CONTENTS

PROJECT ABSTRACT		1
INTRODUCTION		2
PART I	REQUIREMENTS ON THE JOB	5
	Job Sites Studied	5
	Reading Requirements	6
	Special Reading Considerations and Problems	8
	Uses of Reading	9
	Writing Requirements	10
	Mathematics Requirements	11
	Oral Language Requirements	12
	Key Non-literacy Requirements	13
PART II	REQUIREMENTS OF THE VOCATIONAL TRAINING PROGRAM	14
	Courses Studied	14
	Reading Requirements	14
	Special Reading Considerations and Problems	17
	Uses of Reading	18
	Writing Requirements	18
	Mathematics Requirements	18
	Oral Language Requirements	19

PART III	INSTRUCTIONAL RECOMMENDATIONS	21
	Project Overview	21
	Organization of ABE Lessons	23
	Notes on Teaching Vocabulary	24
	Notes on Teaching About the Structure and Organization of Text	26
	Directed Reading Activity	28
	Reading to Accomplish Work	29
	Reading to Learn Information	31
	Counseling the ABE Student	32
	Summary	33
BIBLIOGRAPHY		35
APPENDIX A	KEY TECHNICAL VOCABULARY	36
APPENDIX B	HIGHEST FREQUENCY WORD LIST	52
APPENDIX C	SUMMARY OF OCCUPATIONAL REQUIREMENTS	54

PROJECT ABSTRACT

THE IDENTIFICATION OF LITERACY REQUIREMENTS OF JOBS IN INDUSTRY AND CORRESPONDING VOCATIONAL TRAINING PROGRAMS

1.	Need Addressed:	Meeting the educational needs of adults with minimal literacy skills who wish to enter skilled or semi-skilled occupations.
2.	Population Served:	Adults with minimal literacy skills.
3.	Brief Description:	Specific literacy requirements (reading, writing, listening, speaking, and mathematics) of semi-skilled and skilled occupations in business, industry and vocational training programs were determined. The literacy demands of three work contexts and training programs for each of the ten occupations were then analyzed and reported.
4.	Major Objectives:	To provide educators, counselors, and administrators with a description of the literacy requirements of semi-skilled and skilled occupations and training programs to which functionally illiterate adults aspire.
5.	Products:	A description of the literacy requirements necessary to hold a job in each of ten occupations and the corresponding requirements necessary to succeed in vocational training programs which prepare individuals for each of those occupations is provided. A booklet for each of the ten jobs was prepared.

INTRODUCTION

This project was undertaken in response to a need, expressed by adult basic educators and counselors, for information about the specific literacy skills necessary for success in several occupations. The occupations studied had been identified as desirable careers during informal interviews with adults who were enrolled in basic education programs in the Lafayette, Indiana area. Employment counselors and officials of the Office of Career Development confirmed that the occupations identified for study were appropriate. Because Greater Lafayette offers a wide range of occupational and training opportunities, the project staff was able to study both job sites and vocational training sites for each of the following occupations: account clerk, automotive mechanic, draftsman, electrician, heating and air conditioning mechanic, industrial maintenance mechanic, licensed practical nurse, machine tool operator, secretary, and welder.

Purpose and Audience

This report provides descriptive and instructional information to adult educators at two levels. Factual data are presented in Parts I and II for use in decision making by program developers, administrators, lead teachers, and counselors. Part III presents instructional methods and materials and is meant for use by adult basic education teachers. Members of both groups may be interested in the entire report, but in preparing it the project staff attempted to address the needs of the two audiences separately.

Procedures

To identify reading, writing, speaking, listening, mathematics, and other characteristics which are necessary for success both on the job and in the training program, three job sites and three vocational college courses were studied.

Required reading materials from each of the six settings were evaluated using two widely used readability formulas, the Dale-Chall Formula and the Fry Readability Graph. Readability estimates were computer assisted. A minimum 2000 word sample of written language was taken from each site. Special considerations and problems related to reading the technical materials were identified, and the relative use of reading as a work tool and as a learning tool was determined.

To identify speaking and listening requirements, one hour samples of oral language were recorded at each job site and in each vocational college course. Language recorded at each site was rated for its technical and formal qualities, and computer-analyzed to assess vocabulary and syntax. Written and oral language samples were used to develop the Key Technical Vocabulary List found in Appendix A. The combined language samples from all occupations studied were used to develop the Highest Frequency Word List found in Appendix B. A summary of the literacy requirements for all ten occupations studied is found in Appendix C.

Writing samples were obtained at each of the six sites and used to determine the nature of written communication demands on the job and in the vocational training program.

Mathematics demands were determined through surveys of materials from the job sites and classrooms. Instructors and supervisors responded to a questionnaire about the specific mathematics skills necessary for job and/or training program success.

Important non-literacy characteristics were identified by supervisors who completed a rating scale which asked for their estimate of the importance to job success of such factors as cooperativeness, reliability, and attitude toward work.

The following sections of this report are organized according to the requirements of the job, the requirements of the training program, and instructional recommendations.

PART I

REQUIREMENTS ON THE JOB

Job Sites Studied

At each of three separate job sites the literacy demands placed on one heating and air conditioning mechanic were studied. Reading, writing, oral language and mathematics were the specific literacy skills areas examined. At two of the sites the mechanics were involved in the servicing and installation of residential and light commercial plumbing, heating, and air conditioning equipment. At the third site the mechanic was involved in both major remodeling and installation of heavy commercial heating and air conditioning equipment in large office buildings. An important aspect of such work was knowledge of pipefitting and steamfitting.

From each job site representative samples of reading, writing, and mathematics required on the job were obtained. Samples of oral language requirements were obtained by tape recording a randomly selected one hour period of on-the-job verbal interaction. At each job site, the mechanic's immediate supervisor completed a questionniare which was concerned with the relative importance to job success of eleven worker characteristics. Supervisors also identified the mathematics skills necessary for job success, and estimated the amount of time per week the mechanics used reading and mathematics in their work.

Reading Requirements

Supervisors estimated that the mechanics who participated in the study spent an average of six hours per week in reading on the job. Reading materials from the job sites included work orders, service and installation instructions, building contractor specifications, parts catalogs, and shop drawings, as well as trade handbooks and reference books. The required reading materials employed references to figures, tables, schematic diagrams, shop drawings, and other illustrations. Some frequently used reading materials took the form of tables and charts which had little supporting sentence/paragraph text. Parts catalogs and price lists were often in this format.

The style of writing in most of the materials was highly technical. Work orders were typically written in an informal, abbreviated style which contained essential information but did not follow standard sentence structure. Most of the reading materials surveyed at the job sites were written in a style similar to that presented in Example I.

EXAMPLE I

Style of Writing Found in On-The-Job Reading Materials

A. Building Specifications

> Room thermostats and remote bulb insertion and immersion thermostats shall be two-pipe, of the proportional relay type, except where two-positioned action is necessary, and temperature settings and reset ranges shall be adjustable to best meet actual operation conditions. (Scholer and Associates, 1978, p. 15C-39)

B. Reference Manual

> Another means of computing infiltration into a refrigerated space is by means of the velocity of air flow through an open door. When the door of a refrigerated storage space is opened, the difference in density between cold and warm air will create a pressure differential causing cold air to flow out the bottom of the doorway and warm air to flow in the top. (Copeland Corporation, 1966)

The difficulty of on-the-job heating and air conditioning reading materials was estimated through computer analysis using the Dale-Chall Formula and the Fry Readability Graph. The readability levels, shown in Table I, are reported in ranges of difficulty because of variations in different materials examined at each job site and because of variation in the estimates made by the two formulas. A reading skill range of tenth to college graduate level was necessary to successfully read the on-the-job heating and air conditioning materials.

TABLE I

On-The-Job Readability Levels

Job Site One	Tenth grade to college graduate level
Job Site Two	College to college graduate level
Job Site Three	College graduate level

Readability formulas do not account for factors such as reader familiarity with difficult concepts and vocabulary, motivation, and interest. It is likely that the mechanics who read required materials successfully on a daily basis would have been less successful if asked to read materials from another trade or science. Military

studies of reading and readability (Sticht, 1975) indicate that experienced workers were able to successfully use familiar materials several levels higher than their measured reading abilities should have allowed. The implications of such findings for Adult Basic Education (ABE) instruction are discussed in Part III of this report.

Special Reading Considerations And Problems

As illustrated in Example I, the predominant style of writing found in on-the-job heating and air conditioning reading materials was technical. Interpretation of tables and illustrations was an important aspect of reading for the mechanics who participated in the study. It was essential that they could find information in specifications documents, installation manuals, and service manuals in order to do their work correctly and avoid costly mistakes. In contracting work, reported one mechanic, careful reading of specifications was essential in order to detect omissions and details which could mean the difference between profit and loss on a contract.

Example II depicts information in table and figure format which is typical of that found in the technical reading materials from heating and air conditioning job sites.

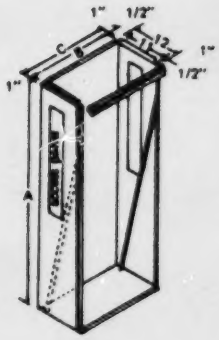
EXAMPLE II

Tables with Accompanying Illustrations

Side/Rear Return Air Filter Cabinets – (Filters not supplied with RA Cabinet)

Furnace Size	12X48¼	18X48¼	18X54½	24X48¼	24X54½	41X54½ rear only
Part No.	JD16F86	JE16F86	J16F86	JF16F86	JA16F86	JB16F86
Height A	48¼	48¼	54½	48¼	54½	54½
Width C	12	18	18	24	24	41
Depth	12	12	12	12	12	12
Duct Conn. B±11"	10X11	16X11	16X11	22X11	22X11	39X11
Filter Provision	1-10x25*	1-16x25*	2-16x25*	2-20x25	2-20x25	4-16x25

*Filter furnished with furnace will fit or can be cut to fit.



(Tappan Air Conditioning, 1978)

Probably the most important aspect of on-the-job reading in heating and air conditioning was the need for thoroughness and caution. All of the participating mechanics stated that failure to read required materials correctly would have costly and sometimes dangerous effects on themselves, their co-workers, and their customers.

Uses of Reading on the Job

Each of the mechanics who participated in the study completed a questionnaire which was designed to determine the nature of reading tasks on the job. It was concluded from the questionnaire that most of the reading on the job was done to obtain important information. The information obtained through on-the-job reading was typically used immediately and not remembered for more than a day or two. After an initial, careful reading, the required material was kept close at hand and frequently referred to until the job was finished. Depending on the nature of the job, mechanics would memorize some information

for the duration of the job. However, as one mechanic stated, "At times it is best to read exacting standards over more often, as they apply to each task."

On-the-job reading in the field of heating and air conditioning was not entirely devoted to accomplishing work. When a system was to be installed, modified, or repaired, trade manuals and professional reference books were consulted. Information from these sources had general applications, and was typically remembered for long periods of time.

Writing Requirements

The ability to communicate through writing was rated to be of average importance to job success by supervisors. It was not important that the mechanics be able to write in complete sentences. It was, however, essential that they communicate important information clearly. Thus, the style of writing used on the job was informal and resembled the syntax of telegrams with non-essential words omitted. Example III illustrates the concise style of writing found at the heating and air conditioning job sites.

EXAMPLE III

On-The-Job Writing Style

A. JOB: Men's restroom copper tubing in tank broke. Is leaking on floor.

B. JOB: No water coming into washbowl in bathroom,

C. JOB: Broken line under house. Crawl space full of water.

A wide range of legibility of handwriting was observed in the

samples of writing collected at the heating and air conditioning job sites. If key information was communicated, the mechanic's handwriting was accepted.

Mathematics Requirements

The mathematics skills required of heating and air conditioning mechanics on the job included addition, subtraction, multiplication, and division of whole numbers, addition and subtraction of fractional numbers, measurement skills, and working knowledge of algebra. Rated as desirable on the job were skill in multiplication, division, and conversion of fractions, ability to solve word problems, and skill in geometry. Approximately six hours per week were spent on mathematics-related tasks according to supervisors. One supervisor added that advanced heating and air conditioning mechanic positions require higher level mathematics skills. Two of the three supervisors rated mathematics skills to be as important as reading skills in contributing to job success. Example IV illustrates one mathematics skill that is called for in heating and air conditioning jobs--using tables of important information.

EXAMPLE IV

On-The-Job Mathematics Requirements

Pressure Equivalents in Fluid Head

Pounds per Square Inch	Inches Mercury	Inches Water	Feet Water
.036	.07	11.0	.083
.433	.80	12.0	1.0
.491	1.0	13.6	1.13

As the above example illustrates, mathematics and reading skills may be used simultaneously in heating and air conditioning jobs.

Oral Language Requirements

Oral language recorded at the job sites combined informal speaking styles with job-related technical concepts and vocabulary. Conversation was sometimes not work related, but as a rule, it focused on job tasks as they were being performed. Giving and following verbal directions were important aspects of oral language at the job sites. When service work was involved, a polite respectful quality was noted in the language of the mechanics. Likewise, in service work it was important to ask questions of customers in order to save steps and troubleshooting time. Example V contains excerpts of typical on-the-job language.

EXAMPLE V

On-The-Job Language

A. Installation

Mechanic: "This measures eighteen. It probably would be best to check it with a plumb bob. That's almost enough for an offset."

Co-worker: "Well, it's going to have to go back, roll back, do you see what I mean?"

Mechanic: "Yea, closer to the wall."

Co-worker: "It's a four and a half."

Mechanic: "This is eight. Fit it up then, by the time it rolls over, it will work. We can come straight up to the right elevation with the lavatory."

B. Customer Service

Mechanic: "Has it been rumbling on you any?"

Customer: "Well uh, a while ago it had been making a squeaking noise."

Mechanic: "Uh huh."

Customer: "You know, and then it just dawned on me this morning that I haven't heard that for a while."

Mechanic: "Yea. Uh, it's really smokey and everything and looks like it's pretty well plugged up. When you look inside it looks like a forest fire. That's why I was wondering if it did rumble or anything on you."

Key Non-Literacy Requirements

Supervisory personnel from each participating business rated several worker characteristics according to their importance to job success. The following characteristics were rated as very important by the supervisors:

Cooperativeness

Good record of attendance

Ability to follow spoken and written directions

Attitude toward work

One supervisor also rated "pride in work" and "trustworthiness" to be very important.

Characteristics which were rated as slightly less important than the above included the ability to communicate through speaking and job knowledge. In no case was reading or mathematics skill rated above any of the qualitites already noted. It should also be noted that job knowledge was rated less important to job success than cooperativeness, record of attendance, attitude toward work, trustworthiness, and ability to follow directions.

PART II

REQUIREMENTS OF THE VOCATIONAL TRAINING PROGRAM

The Courses Studied

The reading, writing, oral language, and mathematics requirements of three courses in a vocational college heating, air conditioning and refrigeration training program were studied. The courses, Heating Air Conditioning and Refrigeration Technology, Air Distribution Systems, and Heat Loss and Gain, were determined by the school administration and instructional staff to be representative of the training program as a whole. The literacy demands of other heating and air conditioning courses were judged to be about the same as those presented here.

Each of the courses studied combined lectures, readings, and practical projects and experiences designed to simulate situations encountered in buisness and industry. Reading, writing, oral language, and mathematics skills were routinely used in all of the courses studied.

Reading Requirements

The amount of time spent using reading and other literacy skills is typically higher in training programs than on the job. This is

due to the need to present large amounts of information in relatively short periods of time. In the vocational college training program much more time was required for reading, according to instructor estimates, than was necessary on the job. The difficulty of the materials and the styles of writing found in materials from the two environments, however, were similar.

Important qualitative differences between on-the-job and training program reading demands were also noted. On-the-job reading was used primarily to get work done, but in the training program reading was used most often as a learning tool. In neither setting was reading used exclusively as a work tool or as a learning tool.

Instructor estimates of the amount of time per week spent on required reading tasks ranged from eight to fourteen hours per week. Thus, it was expected that a minimum of thirty hours per week would be spent reading by the heating and air conditioning students enrolled in all three of the courses.

The style of writing found in required course materials in the training program was, like that found in on-the-job materials, highly technical. Excerpts from training program reading materials are presented in Example VI.

EXAMPLE VI

Training Program Reading Materials

A. Textbook Explanation

"CHANGE OF STATE: The addition of heat to a substance may cause, in addition to a rise in the temperature of that substance, a change of state of that substance. That is, an addition of heat may cause a substance to change from a solid to a liquid, or from a liquid to a gas. (Langley, 1978, p. 3)"

B. Following Sequenced Instructions

"A. Determine the Outside Design Temperature from Table 1. (See paragraph 7-3)."

"B. Determine the Daily Temperature Range from Table 1. (See paragraph 7-4 and 7-5)."

"C. Select Inside Design Temperature for rooms to be cooled. (See paragraph 7-10)."

(National Environmental Systems Assoc., 1975, p. 23)

The levels of readability, or difficulty, of the materials required in the training program courses were similar to those of materials found at the job sites. If reading had been the only learning mode used in presenting new information to students, it would have been more effective to use reading materials written at a lower level than those used by experienced mechanics. However, the vocational college instructors planned lectures and laboratory experiences to coincide with reading assignments. Thus, the effect of textbook difficulty was offset and students were able to acquire basic job-

related information without having to struggle with unfamiliar concepts and difficult reading materials at the same time.

Table II below presents the levels of readability for materials used in the three courses studied. As in the case of the on-the-job materials reported in Part I, readability levels are reported as ranges of difficulty.

TABLE II

Training Program Readability Estimates

Course One	College to college graduate level
Course Two	Eleventh grade to college level
Courst Three	Eleventh grade to college graduate level

It was noted in Part I of this report that readability formulas do not account for such factors as motivation, interest and reader familiarity with subject matter. The notion that motivation and knowledge of subject matter can reduce the perceived difficulty of reading materials is discussed in Part III, Instructional Recommendations.

Special Reading Considerations and Problems

Whereas finding information in texts, tables, figures, and diagrams for immediate use was the predominant use of reading on the job, reading was used most often as a learning tool in the training program.

The training program required a balance of careful reading and the ability to identify and remember important information. Textbooks contained tables and figures similar to those found in specifications and manuals found on the job, as well as sentence and paragraph texts

containing important information. Laboratory tasks required skills in reading and following directions. Typical training program reading materials are illustrated in Example VI above. Tables of key information observed in training program materials were similar to those illustrated in Examples II and IV.

Uses of Reading

As previously discussed, reading in the training program involved both reading to do and reading to learn. Reading to do required skill in finding and using information presented in formats ranging from sentences and paragraphs to tables and shop drawings. Following written directions was also an important ability. Reading to learn required the ability to organize and remember information which was most often presented via sentence/paragraph expository writing paired with graphics.

Writing Requirements

The requirements for both written communication skill and legibility of writing were similar in the training program courses and on the job. The emphasis in both settings was on concise communication of key information. Complete sentences were not required on written assignments or in laboratory work. Legibility became a factor only when it interfered with communication of information.

Mathematics Requirements

Each instructor who participated in the study completed a questionnaire which asked for an estimate of the importance of several mathematics skills to success in the training program for heating and air

conditioning mechanics. It was indicated that skills ranging from mastery of arithmetic processes with whole numbers to processes with fractional numbers, the decimal system, measurement, and ability to solve word problems were necessary for success. Geometry and algebra were rated as desirable skills for heating and air conditioning mechanic trainees. The instructors indicated that from eight to fourteen hours of student time per week was spent using mathematics skills. An almost equal amount of time was spent on mathematics tasks as was spent on reading tasks in the training program courses.

Oral Language Requirements

The style of language recorded during training program lectures was typically informal. The lectures required some prior knowledge of the subject matter and attentive listening on the part of the students. The abilities to follow verbal directions and to take coherent notes were also necessary. Students were expected to relate diagrams on chalkboards and in textbooks to lecture content. Frequently scale models or mock-ups of buildings were used to illustrate information presented verbally by the instructors. An excerpt typical of classroom lectures is presented in Example VII.

EXAMPLE VII

Heating/Air Conditioning Classroom Language

(designing home heating/air conditioning duct work)

Instructor: "Does anybody need help getting started? Do you want to go through the problem where you find static?"

Student: "I have a question. Can you run bathroom, our small bathroom, and the utility together?"

Instructor: "No. The proper way to do that is to put the utility room separate from the kitchen."

The use of oral language in the training program, as on the job, was often applied to problem solving as in the above situation.

PART III

INSTRUCTIONAL RECOMMENDATIONS

Project Overview

For the occupation of heating and air conditioning mechanic, reading, writing, oral language, and mathematics skills required on the job and in the vocational training program were generally high.

The levels of reading skills required on the job and in the training program were estimated to be in the range of upper high school level to college graduate level. It was noted in previous sections of this report that knowledge of key technical concepts and vocabulary, combined with familiarity gained through daily use of required reading materials, can reduce the perceived difficulty of reading tasks.

On the job and in the vocational training program reading was used as a tool for accomplishing work and as a tool for learning. Reading-to-do work was predominant on the job where reading was used to find information and to check specifications for jobs. Supervisors' estimates of the amount of time heating and air conditioning mechanics spent on job-related reading tasks averaged six hours per week.

In the vocational training program, reading was used more often as a learning tool than it was on the job. However, reading-to-do tasks which required fact finding and following directions, similar to on-the-job tasks, occurred frequently.

Writing requirements for the heating and air conditioning mechanics were similar to those of other occupations studied. Neither standard sentence structure nor highly legible handwriting was required. Conciseness in writing tasks was emphasized in both on-the-job and training program settings.

The mathematics demands of the training program were slightly higher than those on the job. Instructors stated that students should have mastered all computational skills extending through the division of fractional numbers. Skill in solving word problems and in measurement were rated as necessary. Geometry and algebra skills were rated as desirable.

Job site supervisors stated that computational processes including addition and subtraction of fractional numbers, measurement and problem solving skills were necessary. Multiplication, division, and conversion of fractions as well as geometry and algebra were rated as desirable.

The oral language used on the job and in the training program required the ability to make use of oral instructions and directions given by supervisors and instructors. Note taking skills and the ability to relate verbal information to graphic illustrations were necessary in the training program courses.

Job site supervisors, when asked to rate several worker characteristics in terms of their importance to job success, rated the

following as very important: good attendance, positive attitude toward work, ability to work cooperatively with others, and ability to follow both oral and written directions. All of these qualities were rated as more important than reading or mathematics abilities. Moreover, two supervisors rated the qualities listed above as more important than job knowledge.

A brief summary of how the literacy requirements of the heating and air conditioning mechanic compare to those of the other nine occupations studied is found in Appendix C.

Organization of ABE Lessons

The recommendations which follow are meant to aid teachers and tutors in designing streamlined lessons which develop literacy skills while imparting job-related knowledge. The majority of the literacy information studied in connection with heating and air conditioning mechanic occupations and training programs was related to reading. Reading demands were found to be high, and even when mathematics, writing, and oral language skills were used by workers and students, they were used in conjunction with reading. This section, therefore, presents a method of organizing ABE lessons which emphasizes reading. Provided background information deals with the teaching of vocabulary and teaching about text structure and organization. The lesson format is based on a directed reading activity (DRA) and includes vocabulary and concept development, sentence and organizational structure, silent reading, and skill development.

The guiding principle of the DRA method of ABE lesson organization is that words, concepts, and skills must be introduced and practiced in situations and materials that are true to life. For example, words, sentences, tables, and illustrations should be similar to those

used on the job or in the training program. It may be possible to teach an interested ABE student the words on the Key Technical Vocabulary List in isolation, but a far better practice is to introduce and practice such words in contexts similar to those found in occupational reading materials.

There may be a wide gap between the reading requirements of occupational materials and the reading abilities of the student. Materials which parallel those found on the job and in the training program can be developed by teachers and tutors. Through paraphrasing sections of textbooks, reference books and manuals, the readability of occupational materials can be reduced so that literacy skills and job-related knowledge can be developed simultaneously.

The value of the DRA approach is that it allows the use of any appropriate reading material in a reading skill or basic job knowledge development program.

Notes on Teaching Vocabulary

The specialized vocabularies of the heating and air conditioning mechanics studied are similar. There are many key concepts and words which are common to the heating and air conditioning trades in general.

The specialized technical words of the Key Technical Vocabulary List should be introduced to ABE students interested in entering the heating and air conditioning field so that both the words and their meanings are recognized. This implies that the words will be taught in a meaningful context.

Two types of specialized vocabulary words occur in specialized fields such as heating and air conditioning. One type of word is

unique to the specific field. The word "plenum" has a very specific meaning to mechanics working in the heating and air conditioning fields, but persons outside of that field probably have never encountered the word. In teaching a word such as "plenum" to ABE students an illustration of its meaning would be essential.

A second type of word which needs attention in ABE lessons is one which has a common meaning in everyday communication but which also has a specialized technical meaning. The word "flashing" is usually used as a verb or adjective, and has several connotations in everyday usage. In the heating and air conditioning field, however, "flashing" is used as a noun referring to sheet metal used in waterproofing roofs. Multiple meanings like these should be pointed out during reading lessons.

The following are suggestions for teaching vocabulary:

1. Pair the word to be taught with the concept or object that it refers to whenever possible.
2. Introduce the word using an approach which focuses student attention on the word.
3. Be sure that the new word is read in context very soon after it has been taught.
4. If in doubt about a student's ability, use the general rule that four to six new words per lesson be introduced. (Learning is typically most efficient when the number of words taught is in this range.)
5. Review vocabulary words frequently.

Sources of job-related vocabulary words and concepts are included in the books cited in the bibliography of this report. Many can be obtained by writing publishers or by checking large libraries. The style and level of writing in the listed materials is often highly technical, thus, if convenient, teacher time could be devoted to preparing lower readability materials which parallel high-level passages.

Notes on Teaching About the Stucture and Organization of Text

The above suggestions on teaching vocabulary words emphasize meaning; words have little use outside of a meaningful context. In the heating and air conditioning field even solitary words on a chart or shop drawing have a meaningful context to a trained individual.

In reading it is important to be aware of special patterns of organization used by writers. Formal technical reading materials are organized differently from the short stories and novels used in teaching reading to most Americans. The expository style of writing used in textbooks and other specialized or technical materials is different from the narrative style of stories and novels at several levels of comparison.

At the sentence level, ABE students should learn that expository style often relates cause and effect. Sometimes this relationship is clearly stated as in the sentence in Example IX-A.

EXAMPLE IX

Stated and Unstated Cause and Effect Relationship

A. The furnace failed because of a clogged fuel filter.

B. The fuel filter was clogged. The furnace failed.

Often, however, the relationship is not stated, as in Example IX-B. In such cases readers who are not expecting cause and effect connections may miss them.

At the paragraph level, writers of expository material often use a format which states the main idea in the first sentence. The last sentence summarizes the paragraph and may connect it to a paragraph that follows. Comprehension and learning can be improved when readers are aware of this organizational technique.

At the chapter level, expository material may contain many valuable aids to efficient reading. Key words are used as headings which introduced important sections. Pictures, diagrams, tables, and figures are used to illustrate important ideas. Introductions and chapter summaries are also available as aids to readers who know how to use them.

ABE students should learn about style factors such as these and use them to improve comprehension. Efficient readers use their knowledge of expository style to organize their reading. Awareness of the use of cause and effect makes them sensitive to such relationships. Knowledge of paragraph and chapter organization is used to develop a "mind set" which is helpful in organizing and remembering important information. Reader-composed questions based on paragraph lead sentences, headings, pictures, and other graphic aids help readers organize, comprehend and remember what is read.

The directed reading activity, described in the next section, is a system which enables the ABE student to become efficient in using organizational factors as aids to comprehension and memory.

Directed Reading Activity

This system of preparing for efficient reading may be used with individual students or with groups. In groups, it requires very little class time to prepare students for reading assignments. For both individual and group use it has been demonstrated to enhance reading efficiency and comprehension.

After a review of previously taught, related concepts and of past assignments the below procedures are to be followed:

I. Develop Readiness for Reading the Assignment:

Purpose: Motivate
Set purposes for reading
Develop vocabulary

Teacher: Ask Questions -

How familiar is the subject matter and vocabulary to your student?

Teach New Vocabulary -

Be concrete: write out the words as you introduce them. Use examples such as objects or pictures, point out word relationships, i.e., cardiograph and cardiovascular relate to cardiac/heart. Have students write the words as they are taught.

Ask Questions to Stimulate Interest -

Focus on titles, pictures, graphs. Relate an anecdote from your own experience or one your students may have had.

II. Direct the Silent Reading of the Assignment.

Develop questions from sub-headings, graphs, pictures, and tables. Try to focus on relationships in the assignment. (In textbooks, useful questions are often provided by the authors).

Have pupils read silently from 5 to 20 minutes, keeping the questions in mind as they read.

Encourage students to ask for help when they are confused. Writing questions down in abbreviated form is a good practice when reading is done outside of class.

III. Discuss Student Answers to Questions

Do not restate the questions unless necessary. Students need to remember the questions or they lose the purpose for reading.

Ask higher level questions to develop comprehension (have students interpret, draw conclusions, and make inferences as well as recall facts).

IV. Reread as Necessary

When answers demonstrate confusion, have the student reread the appropriate small section to determine the reason for the confusion.

V. Follow-up and Skill Development

Confusion or lack of comprehension may signal a need for extra work on vocabulary, concept building, or word recognition skill.

In this phase of the lesson important mathematics and other skills can be related concretely to the reading assignment.

REMEMBER:

The DRA is a system, a routine, that you want your students to learn to use independently. Remind your students of this - tell them why you use the DRA system. It will help them now and in their future study.

Reading to Accomplish Work

The phrase reading to do has been used in research and development

projects done for the U.S. armed forces (Sticht, et al., 1977). Reading to do refers to the use of reading for the purpose of getting work done. It involves following written directions and reading to find information which will be used immediately. Such information need not be learned or remembered. Looking up telephone numbers, finding information in a policy manual, or finding important data in a table, chart, or figure are examples of reading to do. Preparation of ABE students for reading-to-do tasks can be incorporated in a directed reading activity lesson.

When lesson materials contain occupationally-relevant concepts, ABE students are given important background information which will make higher level training easier. Therefore, lessons should employ materials which are similar in structure and content to those found on the job or in the vocational training program. Paragraphs, tables, charts, and figures might be used verbatim from on-the-job or instructional materials. Alternatively, such materials might be paraphrased and reduced in difficulty to match student abilities.

Given appropriate materials and a period of orientation to them, the structural and organizational features of the table, chart, figure, paragraph, or chapter should be pointed out to the student (see Notes on Teaching About Structure and Organization of Text). This is essentially the first step of the DRA described above. When the materials have been introduced, the student should be directed to find a particular fact in the material. In subsequent lessons, the difficulty of information-finding tasks should be increased.

Skill in following written directions can be developed using

a DRA system and materials similar to Example X. Initial activities should contain only one or two steps.

EXAMPLE X

Written Directions

1. Before operating any motor or other moving parts, they must be lubricated with the proper oil or grease as necessary.
2. Remove or loosen shipping retainers under motor compressors.
3. Check high and low-pressure control cut-in cut-out points.
4. After the compressor is started continue charging until the system has sufficient refrigerant for proper operation. (Copeland, 1966, p. 24-19)

In information-finding lessons, the emphasis should be on an understanding and careful identification of the required fact. Likewise, in lessons on following directions understanding and careful execution of the required steps must be emphasized.

Reading to Learn Information

Skill in learning printed information for future use is very important in vocational training programs. The reading skills necessary for reading to learn (Sticht, et al., 1977) are taught and systematically practiced in directed reading activity lessons. That is, the use of previewing, attention to graphic and contextual information, and the organizational factors discussed in Notes on

Teaching About the Structure and Organization of text, above, should be practiced and learned during each DRA lesson. Questioning and rereading, also aspects of a DRA, reinforce important learning skills.

Sources of materials for use in reading-to-learn lessons, like those employed in reading-to-do lessons, should be occupationally-oriented (See Bibliography). ABE students who receive reading instruction through job-related reading materials develop not only reading skills but gain important job knowledge as well.

Counseling the ABE Student

ABE students should be made aware of the importance of reliability, cooperation, ability to follow directions, and other factors noted in Part I of this report. On the basis of the responses of supervisors surveyed in this study and previous research (Sticht, 1975), it seems that such characteristics may contribute as much to job success as reading and mathematics skills. Role-play activities which involve consideration for others and following directions may be a valuable part of ABE lessons designed to prepare adults for employment.

The literacy demands of the heating and air conditioning mechanic jobs and training program courses are high. It is, therefore, important that teachers, tutors, and counselors consider the facts presented earlier in this report, the individual student's levels of motivation, and the individual's literacy skill development before beginning to prepare the student to enter a heating and air conditioning job or vocational training program. Frequency and intensity of

lessons, choice of instructional materials, and long-term duration of the instructional program will vary according to the students' literacy skill levels, especially in reading and mathematics.

This does not mean that students with low level literacy skills should be discouraged from preparing for a heating and air conditioning career. It does suggest, however, that an early and realistic estmate be made of the time and effort required to reach the goal of employment or formal training.

Summary

The literacy demands of heating and air conditioning jobs and training program courses were found to be high. It is probable that individual experience and familiarity with specialized information reduces the perceived demands of job and training program tasks. The exact extent of such a reduction, however, is not known.

It was observed that the vocational training program for heating and air conditioning mechanics provided students with experiences that were very similar to on-the-job tasks. Reading materials from the training program which presented important basic occupational concepts through texts were similar in difficulty to those found at the job sites. Research supports the practice of reduced readability levels when difficulty concepts are presented in written form. It was also observed that instructors took measures to reduce the effect of difficult reading materials.

Due to the nature of the project, instructional recommendations emphasized the development of reading skills. Other literacy and non-literacy requirements were recognized as important but it was

clear, even in cases where high level mathematics skills were necessary, that good reading skills were essential for the job of heating and air conditioning mechanic.

The recommended approach to ABE reading instruction was a directed reading activity (DRA), because it is systematic, provides for essential skill development and practice, and permits the use of any relevant reading material. Suggestions were presented for teaching vocabulary and on the use of important structural and organizational factors which are related to reading comprehension and memory.

Two uses of reading, reading to do and reading to learn, were discussed separately because the skills they require are distinct. Reading to do requires the ability to find information for immediate use; long-term memory is not necessary. Reading to learn requires awareness of organizational factors which aid learning and remembering.

Non-literacy factors were discussed in the section, Counseling the ABE Student, because on-the-job supervisors rated several factors such as attendance and cooperativeness to be more important to job success than reading and mathematics ability, even though the literacy demands were high.

Finally, it was recommended that in using the information and recommendations presented in the report ABE teachers should be well acquainted with the occupational interest and motivation as well as the literacy skills of their students. The literacy demands of heating and air conditioning jobs and training program courses are stringent. Students whose literacy skills are very low may be unwilling or unable to spend the time and effort necessary to develop the required skills. Such students should be encouraged to change their occupational goals.

BIBLIOGRAPHY

Occupationally-Related Materials

Copeland Refrigeration Manual. Sidney, Ohio: Copeland Corporation, 1966.

Equipment Selection and System Design Procedures. Chicago: National Environmental Contractors Association, 1973.

Instruction Manual for Steamfitter--Pipefitter Apprentices. Washington, D.C.: Joint Steamfitter-Pipefitter Apprenticeship Committee, 1967.

Langley, B. C. Refrigeration and Air Conditioning. Reston, VA: Reston Publishing Company, Inc., 1978.

Load Calculation. Arlington, VA: National Environmental Systems Contractors Association, 1975.

Scholer, W. et. al. Specification: West Lafayette Campus Classroom, Office, Laboratory Building. Lafayette, Indiana: Walter Scholer and Associates, Inc., 1978.

ABE Teacher References

Bowren, F. R. and M. V. Zintz. Teaching Reading in Adult Basic Education. Dubuque, Iowa: Wm. C. Brown Publishers, 1977.

Duffy, T. M. "Literacy Research in the Navy". In Sticht, T. G. and D. W. Zaph (Eds.), Reading and Readability Research in the Armed Services. (HumRRO FR-WD-CA-76-4). Alexandria, Virginia: Human Relations Research Organization, 1976.

Harris, A. J. and E. R. Sipay. How to Teach Reading. New York: Longman Inc., 1979.

Ransom, G. A. Preparing to Teach Reading. Boston: Little, Brown and Company, 1978.

Rauch, Sidney J. (Ed.). Handbook for the Volunteer Tutor. Newark, Delaware: International Reading Association, 1969.

Sticht, T. G. (Ed.) Reading for Working: A Functional Literacy Anthology, Alexandria, Va., Human Relations Research Organization, 1975.

Sticht, T. G.; Fox, L. C.; Hauke, R. N.; and D. W. Zaph, The Role of Reading in the Navy, Alexandria, Va., Human Relations Research Organization, 1977.

APPENDIX A

TECHNICAL VOCABULARY LIST

This list is based on the total oral and written samples of the language of heating and air conditioning mechanics both on the job and in the training program. Words included in the most frequent 1000 words of the Kucera-Francis list (based on adult language) have been deleted. The list was also edited to remove numerals; labels; names of people, places, products, and companies; contractions and possessives; and colloquialisms resulting from the oral language samples.

Some words included in the list are relatively uncommon words that occurred in the total language sample and are not necessarily technical terms. Thus, the list should be treated as a source rather than a criterion. The 83 most common words have been marked with an asterisk.

Total Sample Words = 19,937

Different Words = 2,841

ability	adequate	alternating	appropriate	automatical
abnormally	adjacent	alternator	approved	automobile
absorbed	adjoining	altitude	approximate	availability
absorbing	adjust	aluminized	arbitrary	avoided
absorbs	adjustable	ambient	arch	awhile
accepted	adjusted	amperage	Archimedes	backer
access	adjustment	amperes	architect	backfill
accessible	advanced	amplifies	arguing	backs
accessories	advantaged	angle	arm	backup
accessory	advantages	angular	arranged	bacteria
accomplish	affect	anomaly	arrangement	bag
accordance	affected	anybody	article	bags
accordingly	affecting	anymore	asking	baked
accumulate	affords	anytime	asphalt	balance
accumulating	agency	anywhere	assemble	balanced
accumulatory	ahold	apart	assembled	barely
accuracy		apartment	assembly	bark
accurate	alarm	apparatus	assist	barrel
accurately	alcohol	appearance	assistance	base
actions	alcove	appears	assumed	basement
activates	alignment	application*	assure	basements
acts	allow	apply	atmosphere	basically
actual	allowance	appreciable	attached	basin
actuated	allowed	apprentice	attempted	basins
adapted	allows	approached	attract	basket
add	alloy	approaches	attraction	basketball
adds	alternate	approaching	automatic	bath

bathroom	blocking	BTUs	calculation	cavitation
bathrooms	blow	bubbles	calls	cement
battery	blower	bud	cam	centered
beam	boil	build	campus	centerline
bearing	boiler	builder	candy	centers
bearings	boiling	builds	cap*	certified
beat	boils	built	capable	chalk
becomes	bolted	bulb	capacities	chamber
bedded	bonds	bulge	capacitor	changed
bedding	border	bulk	capacity*	changing
bedrooms	bothering	bumps	capillary	chapters
begins	bottom*	bunch	capital	characteristic
bell	bought	buoyancy	carbon	charged
belt	bounce	buoyant	carefully	charging
bend	box	burial	carpeting	chart
bends	bracket	buried	carry	charts
bet	brackets	burner	carrying	cheap
bicycle	branch*	burners	casing	cheaper
bid	branches	burning	cast	check*
bigger	break	butane	catalog	checked
bimetal	breaks	buttons	catalyst	checkout
bit	breeze	buy	catch	chemical
bits	broke	cabinet*	caterpillar	chicken
blacker	broken	cabinets	caught	chips
blade	bronze	cadmium	caused	chisel
block	brother	calculate	causes	circuit*
blocked	BTU	calculated	causing	circuits

clamp	colds	compounds	connection*	contributing
clamps	collect	compress	conscious	controlled
classes	column	compressed	conservation	controller
classification	combination*	compressing	considerable	controlling
clean	combined	compression	considerate	controls*
cleaned	combo	compressor*	consisting	convenience
cleanliness	combustion	compromise	constant	convention
cleared	comfort	computation	constructed	conversion
climates	comfortable	computed	constructing*	convert
clock	comment	computing	consumption	convex
closely	commercial	concerning	contact	convey
closer	commonly	concrete	contactor	conveyed
closes	commutator	condensate	contacts*	conveyor
closest	compact	condensating	contain	cool
closet	companies	condense	contained	cooled
closets	compared	condenser*	container	cooler
closing	competence	condensers	containers	cooling*
cloth	competent	condenses	containing	coolness
clothes	competition	condensing*	contains	cools
coal	completed	condition	contaminate	coop
code	completes	conditioned	content	copper
codes	complex	conditioning*	continual	cork
coffee	complexity	conductor	continues	corn
coil*	complicate	conform	continuous	correct
coils	compiled	connect	contract	correctly
coke	component	connected	contractor	correspond
colder	components	connecting	contribute	corrosion

counter	cycles	deluxe	devises	displaced
cover	cycling	demand	diagonal	displacement
covers	cylinder	denser	diameter	displaces
cracked	damage	densest	die	display
cradle	damaged	density	differ	dissimilar
crankcase	damages	depend	differed	distances
crankshaft	damper	dependable	differentiate	distribute
crawl	dampers	dependence	difficulty	distribution
create	danger	dependent	diffuser	distributor
created	dangerously	depending	dig	disturb
crew	dawned	depends	digging	disturbance
critical	daytime	depressed	dilemma	dizziness
cross	deals	describe	dilutes	dock
crowd	debris	describes	dimension	collar
crown	decent	description	dimensions	dollars
crying	decrease	designation	directed	domestic
cube	decreases	designer	directions	doors
cubes	decreasing	designers	dirt	doorway
cuff	defective	designing	dirty	dotted
cup	defined	desirable	disc	doughnuts
currently	definitely	desired	discharge*	downstairs
currents	defrost*	detail	discharged	downward
curved	defrosted	determination	disconnect	drain
customer	degrees	develop	discontinuing	draw
customers	deliver	device	discussed	drawing
cutout	delivered	devices	discussing	drawings
cycle*	delivery	devise	displace	drawn

drink	electrical*	energy*	evaporates	existing
drop*	electricity	engine	evaporating	exists
dropped	electrode	enter	evaporation	exit
drops	electrodes	entering	evaporative	expanding
dry	electromagnet	enters	evaporator*	expands
duct*	electron	enthalpy	event	expansion*
ducts*	electronic	entrance	eventually	expensive
dug	electrons	environment	everybody	experiment
dull	element	equal	everyone	exposed
dump	elevation	equals	evidently	exposure
durable	eleven	equilibrium	exact	expressed
dust	eliminates	equipped	exactly	extend
duty	elsewhere	equivalent	examine	extended
dynamically	embedding	erosion	examples	extension
easier	emersion	erratic	exceed	external
economical	employing	error	excellent	extra
edge	employs	escape	exceptional	extremely
effectively	enamel	essential	excerpt	factor
effectiveness	encased	establish	excess	factory
efficiency	encases	estimate	excessive	facts
efficient	enclose	estimated	exchanger	failure
eight*	enclosure	estimates	exclusively	fairly
eighteen	enclosures	estimating	exerted	falls
eighth	encounter	etc.	exerting	false
eighths	ends	ether	exerts	fan
eighty	energized	evaporate	exhaust	fashioned
electric*	energizes	evaporated	exist	faster

fastest	firmly	fluidic	freezing	gauge*
faucet	fit	fluids	frequently	gauges
fault	fits	flux	friction	gear
features	fitted	foam	frost	geared
fed	fitting	foamed	frosting	generated
feeder*	fittings*	folks	frozen	geographic
feeds	fixed	follow	ft.	giving
fell	fixture	follows	fuel	glad
fever	fixtures	foods	fuels	glass*
fiberglass	flame	foot*	functioning	goes
fifteen	flange	footing	fundamental	gold
fifty	flare	forced	furnace	governed
fig	flaring	forest	furnish	gpm
figured	flash	forgot	furnished	grab
filament	flavor	formation	fusible	grabbed
filings	flexible	formed	fusion	grade
fill	float	formula	gable	grades
filled	floatless	forth	gain	graph
filling	floats	forty	gallon	gravity
film	flooded	forty-five	gang	grease
filter	flooding	forty-six	garage	greatest
filters	flow*	foundation	gas*	greatly
fingers	flowing	fourteen	gaseous	grey
finish	flows	fraction	gases	grille
finished	flue	frame	gasketing	grilles
fins	fluctuation	freely	gaskets	groove
fireplace	fluid*	freeze	gate	grow

grown	hello	ideal	inform	insulation
guess	helped	identify	inherent	insurance
guy	hence	ignition	initial	insure
guys	hero	illustrate	initially	integral
halls	hiding	immediately	initiated	intend
hallway	hill	immersed	initiating	intends
hammer	hinges	impeller	injuries	intensity
hanced	hits	impingement	injury	interior
handle	holding	imported	inlet	intermittant
handled	holds	imposed	inlets	intermitted
hang	hole	impossible	inner	internal
hanger	holes	inch	input	interrupting
happen	hook	inches*	insert	interrupts
happens	hopefully	included	inserted	intersection
happy	horizontal	incoming	inspected	invented
hardens	horsepower	incorrect	install	iron
harvest	hose	increases	installation	isolated
harvested	houses	increasing	installed*	items
heat*	housing	independent	installer	jackets
heated	hovered	indicate	installers	jar
heater	humidity	indicates	installing	jobs
heaters	hunting	indicative	instance	joint*
heating*	hurt	indoors	instances	joints
heavier	hurting	inertia	instruction	judgment
heavily	hydraulic	inexhaustive	instructor	junk
height	ice*	inferior	insufficient	keeping
helical	icemaker	infiltrating	insulating	keeps

kill	liberated	locating	makeup	merchandise
kinetic	library	location*	manhole	mess
kit	lift	locations	manholes	message
kitchen	lifted	locked	manifold	metal*
kits	lifts	locks	manual	metals
knock	lighter	logical	manually	meter
knows	lightest	looks	manufacture*	metered
laid	lightweight	loop	marble	metering
largest	limit	loosen	margin	metric
lasted	limiting	lose	mark	midair
latent	lineal	loses	marketplace	milder
lavatory	lined	loss	marking	millivolts
laying	linting	losses	match	minimum
layoff	liquid*	louvers	matching	minus
layout	liquids	lowered	materials	minute
leader	liquified	lowering	maximum	missed
leading	listed	lp	measure	mistake
leak	listing	lubricated	measured	mixed
leakage	lists	lungs	measurement	misture
leaks	lit	machine	measures	model
leaving	lites	machined	measuring	models*
lengthen	liver	machines	mechanic	modification
lengthening	lives	magnetic	mechanical	modulate
lengths	load	mail	medium	modulating
levels	loading	mains	melt	moisture
lever	locate	maintain	melted	molasses
liberate	located	maintains	melts	mold

molecules	night	occur	otherwise	paragraph
Monday	nine	occurred	ought	parallel
monitoring	nineteen	occurs	ours	parcels
monitors	ninth	offset	ourselves	partial
mortar*	ninety	offsets	outdoors	partially
motion	nipple	ohms	outer	partition
motor	noise	oil*	outlet	partitioned
motors	nominal	oils	outlets	pass
mount	non	ok	outlined	passing
mounted	nonadjustable	older	output	patented
mounting	nonpolluting	oneway	overall	path
multi	nonposition	onto	overcharge	paths
multiple	normally	opening	overcome	paying
multiplication	northeastern	openings	overflow	pension
multiply	noted	opens	overflows	percent
multiplying	notice	operate	overhead	percentage
multispeed	noticed	operated	overload	perfect
naturally	nutritive	operates	overloads	performance
nearest	nuts	operating*	overtime	performs
needle	object	operators	owner	perimeter
negative	objects	opposite	oxide	periodic
neighborhood	observed	optional	oxidized	periods
nema	obstruction	ordered	page	permanent
net	obtain	orifice	pan	permit
neutral	obtaining	original	panel	permits
newspaper	occasional	originate	panels	permitted
nice	occupant	OSHA	papers	permitting

pertinent
petroleum
phase
physics
pick
picking
pieces
pillow
pilot
pin
pipe*
pipeline
pipes*
piping
piston
pistons
pits
pitted
planter
plaster
plastic
plate
plates
playing
plenum*
plenums
pliable
plug
plugged
plumb
plus
pneumatic
pocket
poisoning
policeman
ployurethane
porous
port
portion
positioning
positive
possibility
possibly
posterity
potential
pound*
pounds
pour
powered
practicable
practical
practice
praying
preceeding
precise
preheat
prepared
preservation
preserves
pressures
prevent
preventing
previously
primarily
principles
print
printing
procedure
procedures
processes
produce
produced
proficient
progresses
progressive
promptly
pronounce
propane
proper*
properly
properties
proportion
proposed
proprietor
protect
protected
protecting
protection
protectors
provides
providing
provision
psc
psi
psig
ptc
published
puffing
pulled
pulley
pump*
pumped
pumping
pumps
purchased
pure
purposes
push
pushing
puts
putting
quadrant
quantities
quantity
quarter
quickly
quiet
quit
railroad
rains
raise
ranging
rapid
rapidly
rated
rating
reaches
reaching
readily
reads
rear
reasonable
reasoned
recall
receiver

receives
receptacle
recirculate
recognized
recommendation
recommended
recorded
recording
records
recreation
reduce
reduced
reducer
reduces
reducing
reduction
reeds
refer
referred
refreezing
refrigerant*
refrigerate*
regained
region
register
registered
registers
regular
regulates
regulating
regulation
regulator
reinforced
related
relations
relative
relatively
relay*
relays
release
released
remain
remains
remodel
remote
remove
removed
removing
rents
repair
repeated
repel
replacement
represent
represented
representing
represents
require
requirement
requires
reservoir
reset
residence
residences
residential
resistance*
resistant
resisting
resists
respective
responds
responsible
restriction
retainers
retains
retarded
returning
returns
reversed
reversing
review
rich
ring
rings
rise
rises
rod
rods
roll
rolled
rolls
roof
rooms
root
rope
rose
rotor
rough
round
rubbing
rugged
rule
ruler
rules
rumble
rumbling
runner
runs
saddle
safe
safely
safety*
sag
sand
sandwich
sanitary
sank
satisfactory
satisfied
saturated
saturation
Saturdays
saving
scaled
scope
seal
sealed
sealer
seam
seasons
sections
securely
sedimentation
seldom
select

selected	shelf	sixty-eight	soil	squeaking
selection	shell	sixty-two	solar	squeaky
selector	shielded	sizable	solder	stable
self	shiny	sized	soldered	stack
selling	shipped	sizes	solenoid	stacks
send	shipping	sizing	solid	standing
sensation	shortage	skin	solidly	standpoint
sensible	shortening	skip	solution	starter
sensing	shower	slab	solve	starters
sensitive	shows	slanting	solving	starting*
separate	shunts	slick	somebody	starts
separately	shut	slide	somehow	startup
separation	shutoff	slightly	someplace	starved
servicing	shutters	slings	something	stated
settings	sick	slip	somewhere	static
settle	sides	slips	soot	stationary
seventeen	sight	slope	source	steady
seventy-seven	sign	sloped	sources	steam
sewage	significant	slow	spaces	steamfitted
sewer	silencer	slowing	specification	steel*
sewers	silver	slugging	specified	stereophonic
shade	simplify	smaller	speed	stick
shaft	sink	smell	spigot	sticks
shape	sit	smelling	spill	stocked
shaped	site	smoky	spoilage	stocking
sharp	sixteen*	smooth	spot	stone
sheet	sixty	soft	spout	stopping

storage*	suction*	switch*	terrazzo	tight
store	sufficient	switching	tested	tightly
stored	suggest	tables	tetrachloride	tile
storeroom	suitable	takeoff*	textile	till
storm	summarize	takeoffs	thank	tin
straighten	sump	takes	thermal	tire
strainer	Sundays	talking	thermistor	tires
strains	super	tamped	thermocouple	tissue
stranger	superfluous	tank	thermodynamic	tolerate
straps	superheat	tap	thermometer	tone
stream	superheated	team	thermostat*	tongue
strongwall	superintend	tear	thick	tons
structure	supplement	teaspoons	thin	tools
structures	supplied	technician	thinks	torque
stuch	supplies	technique	thirteen	totals
stuff	supply*	tees	thirty	touch
style	supplying	telling	thirty-five	touching
styles	supported	tells	thirty-four	tower
subcooler	supporting	temporarily	thirty-one	towers
submerged	supposed	tend	thirty-two*	traffic
substance	surely	tends	thoroughly	trailer
substances	surge	tentatively	thrown	trains
subtract	surplus	term	thrust	transfer
subtracted	surrounding	termed	Thursday	transferred
subtraction	suspension	terminal	ticket	transferring
succeeding	sustains	terminals	ticks	transformed
success	swears	termination	tied	transition

transmission
transmitted
transported
trap
trash
travel
tray
trench
trimmed
trips
truck
trunk*
tub
tube
tubes
tubing*
tunnel
turbulence
turbulent
turning
turns
twelve
twenty*
twenty-eight
twenty-five
twenty-four
twenty-seven
twentythree
typical
tyrant
UG
unattended
uncluttered
underground
underneath
understood
undisturbed
unevenness
uniform
unit*
units
universal
unknown
unless
unlike
unnecessary
unopened
unwatched
upper
upstream
upward
urinal
urinals
usage
uses
utility
vacuum
valuable
valve*
valves*
van
vane
vapor
vaporization
vaporizes
vapors
variable
variables
variation
varies
vary
vault
velocities
velocity*
vent
ventilating
ventilation
vertical
vertically
vessel
vessels
vibrating
vinyl
viscosity
vitrified
voids
volt
voltage*
volts
volumes
von
vulnerable
waist
wait
walls
wants
warm
warmed
warmth
washes
washing
waste
watch
waterproof
waters
weather
weatherproof
Wednesday
weighed
weight*
weighted
weightless
weights
wet
wheel
wheels
whenever
wick
widely
width
willing
winding
winter
wire
wired
wires
wiring
wise
woke
wonder
wondering
wood
wooden
wool
worksheet

worried

wrap

yard

yearly

yeast

yell

yesterday

yours

zero

APPENDIX B

HIGHEST FREQUENCY WORD LIST

The 100 words on the following page represented 45% of the words used in all the language sampled. This list is based on the combined oral and written language samples from all occupations studied. It shows the words used most frequently by adults in the ten jobs studied and in the vocational training programs corresponding to those jobs.

Total Words	=	180,000
Total Different Words	=	9,000

the	will	your	see
of	one	was	more
to	not	get	these
and	an	has	into
a	there	must	just
is	can	any	them
in	when	he	down
it	out	got	time
for	we	know	about
that	which	then	been
you	what	don't	some
be	do	each	business
or	up	air	how
on	pressure	check	its
are	two	that's	back
I	so	but	over
this	they	system	work
with	here	through	would
as	other	valve	temperature
by	ok	going	same
if	right	well	also
have	no	use	where
all	used	than	now
at	may	it's	only
from	should	go	like

APPENDIX C

SUMMARY OF OCCUPATIONAL LITERACY REQUIREMENTS

This appendix presents a brief summary of the literacy requirements for all ten occupations studied.

SUMMARY OF OCCUPATIONAL LITERACY REQUIREMENTS

	On The Job		Training Program	
	Reading	Mathematics	Reading	Mathematics
Account Clerk	College to college graduate level	addition, subtraction, multiplication, division, decimals, fractions, business machines	11th grade to college graduate	addition, subtraction, multiplication, division, fractions, decimals. algebra
Automotive Mechanic	9th to college graduate level	basic processes, decimals, fractions, measurement	9th to college graduate level	basic processes, decimals, fractions, measurement
Draftsman	10th grade to college graduate	basic processes, through geometry, algebra, trigonometry	9th grade to college level	basic processes, through geometry, algebra, trigonometry
Electrician	college to college graduate level	basic processes, throguh geometry, algebra, trigonometry	10th grade to college graduate level	basic processes, through geometry, algebra, trigonometry
Heating and Air conditioning Mechanic	10th grade to college graduate level	basic processes, decimals, fractions, measurement, algebra	11th grade to college graduate level	basic processes, fractions, decimals, measurement
Industrial Maintenance Mechanic	10th grade to college graduate level	basic processes through trigonometry	10th grade to college graduate level	basic processes, decimals, fractions, measurement
Licensed Practical Nurse	10th grade to college level	addition, and subtraction--more necessary to dispense medication	12th grade to college graduate level	addition and subtraction
Machine Tool Operator	9th to college graduate	basic processes, decimals, measurement	9th grade to college level	basic processes, decimals, measurement
Secretary	College to college graduate level	basic processes, decimals, fractions, business machines	10th grade to college level	basic processes, decimals, business machines
Welder	few materials--reading of single word information required	basic processes, fractions, decimals, measurement	8th grade to college graduate level	basic processes, fractions, decimals, measurement, algebra